

Chapter 42

LUCAS FUEL SYSTEM COMPONENTS AIR-FUEL RATIO CONTROL

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*This chapter revised by Amendment No. 126
August, 1956*

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The information in this chapter has been supplied by Messrs. Joseph Lucas, Ltd., and all enquiries regarding their products should be made to them.

THE AIR-FUEL RATIO CONTROL (Fig. 1) is an over-riding control designed to prevent the occurrence of excessive temperatures in the combustion chamber. It comes into operation on acceleration when, apart from damage, excessive temperature may lead to stalling or surging of the compressor. At high altitudes, where flame extinction is possible, the control will exert its influence and prevent the onset of extinction. In addition, the temperature is maintained at a safe value should the effects of altitude, mechanical damage or deterioration tend to cause the engine to become too hot.

Variations of the basic type of control unit are available to suit individual installations, the differences being in the calibration values and installation fittings.

A typical complete type number (AFR.3/4C) comprises the basic type designation (AFR.3), followed by a stroke number (/4) which is a code reference indicating the customer's installation, and a final letter (C) to indicate the performance schedule to which the particular unit has been calibrated.

The control operates on the principle that by maintaining the fuel to air ratio within certain pre-determined limits the temperature rise of combustion can also be controlled to a known value. Also since the variation in compressor temperature is small, the total temperature after combustion will be maintained very nearly constant.

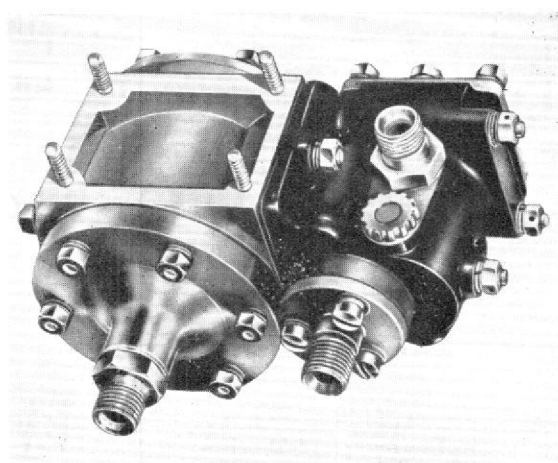


Fig. 1. Air-Fuel Ratio Control.

Since over the greater part of the operating range of the engine, the air mass flow through the engine depends very nearly on the compressor pressure absolute, by controlling the ratio of pressure absolute to flow, a certain value of fuel to air ratio is maintained, and combustion temperature controlled accordingly. The line pressure between the fuel control valve assembly and the fuel flow distributor is used as a direct measure of flow and is balanced against compressor pressure absolute in the control unit.

The unit (see Fig. 2) comprises a cast body subdivided into a capsule chamber (14) and a valve chamber (6) by a pivot plate assembly (2) carrying a rocker lever (12) which extends into both chambers.

The end of the rocker lever extending into the valve chamber has a socket in which is fitted a half-ball (7) which seats on the orifice (8) to form a valve, this valve being normally closed by a suitably compressed spring (5) the loading of which may be varied by the adjustment screw (4) in the valve chamber cover. Fuel at pump servo pressure is supplied to the underside of the orifice through a filter.

The rocker lever is operated by fuel at line pressure through a diaphragm (11), piston (10) and push rod (9). The upper end of the push rod operates against an adjustment screw (3) in the rocker lever.

The other end of the rocker lever, which extends into the capsule chamber, is pivoted in such a manner as to be acted upon by forces produced as a result of pressure on the diaphragm (13) and on an evacuated capsule stack (1). Since diaphragm and capsule stack have the same effective areas, the effects of pressure inside the chamber are cancelled out, leaving the rocker arm responsive to a force proportional to absolute pressure on the underside of the diaphragm (13). This is connected to compressor pressure and movement of the rocker lever is therefore dependent on the value of compressor pressure P_c opposing the fuel line pressure P_f .

Under steady running conditions the unit is inoperative.

During acceleration the system is in equilibrium, with the half-ball in the servo valve orifice just floating. Since, as already explained, the line

T.161439	Spanner—strainer assembly.
T.164159	Spanner—orifice assembly.
T.174678	Spanner—valve spring adjusting screw.
T.194435	Locking plate—diaphragm assembly.
T.196217	Extractor—blower pressure diaphragm cover.
T.196218	Attachment—dial micrometer—checking rocker lever pre-load.
—	Test rig—calibration and performance testing.
T.174675	Spanner—orifice assembly.
T.196595/H	Hydraulic assembly fixture complete—general assembly.
T.196595	Adapter plate only for above.

— Test rig—calibration and performance testing.

T.174675 Spanner—orifice assembly.
T.196595/H Hydraulic assembly fixture complete—general assembly.

T.196595 Adapter plate only for above.

Fig. 2. Schematic diagram showing construction and operation of air-fuel ratio control.

1. Evacuated capsule stack.
2. Pivot plate assembly.
3. Adjustment screw.
4. Adjustment screw.
5. Spring.
6. Valve chamber.
7. Half ball.
8. Servo valve orifice.
9. Push rod.
10. Piston.
11. Diaphragm.
12. Rocker lever.
13. Diaphragm.
14. Capsule chamber.
15. Pump.
16. Control valve assembly.
17. Distributor.

CHECKS AND PRECAUTIONS BEFORE DISMANTLING

Study any complaints reported with the unit and examine it externally for visible signs of damage

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<i>Tool No.</i>	<i>Description</i>
G.56967	Gauge—operating needle adjustment.
T.140539	Jig—assembling and dismantling—rocker lever assembly.
T.151165	Sealing plate—pressure test—rocker lever assembly.

Study any complaints reported with the unit and examine it externally for visible signs of damage

LUCAS FUEL SYSTEM COMPONENTS

de Havilland
Ghost Forty-eight

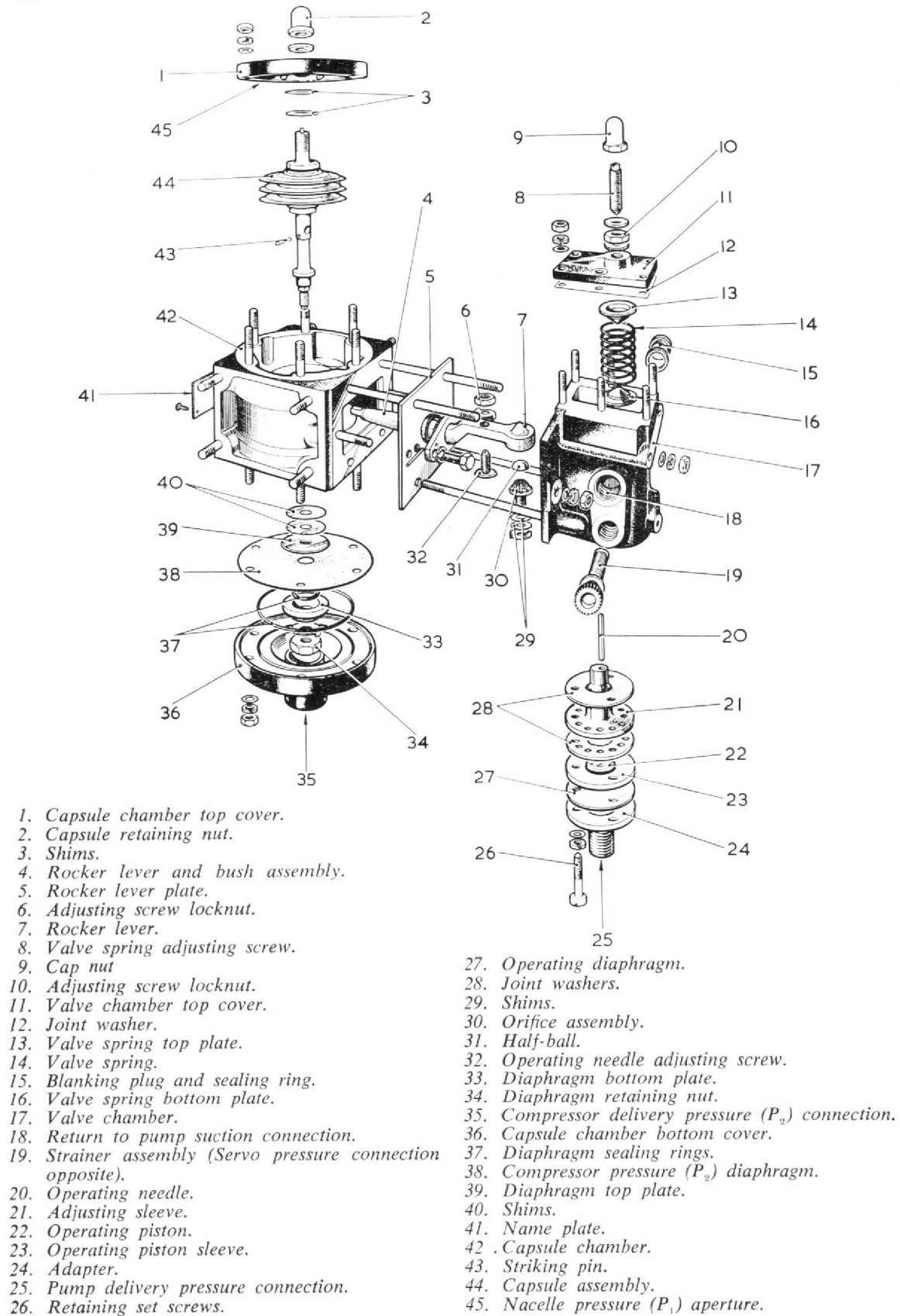


Fig. 3. Dismantled view of air-fuel ratio control unit.

or interference, particularly with regard to the locking wire on the valve spring adjusting screw domed locknut. Check that all connections have been blanked off with dust caps to exclude foreign matter from the interior of the unit. Inspect all exposed threads for damage in transit.

Remove the installation fittings from the unit and, if its condition will allow it to be tested, mount the unit on the test rig and carry out a performance calibration check in accordance with the instructions given on page 13. If the unit is reported to be leaking however, it should be subjected first to a leakage test under the conditions specified on page 15 in order to locate the source and nature of the leak and facilitate investigation of the cause.

DISMANTLING THE AIR-FUEL RATIO CONTROL UNIT

One or more clean metal receptacles should be placed adjacent to the work and the dismantled components should be placed in the receptacles for safe storage pending inspection.

It is recommended that only one set of components be present on the workbench at any one time in order to avoid the accidental transfer of parts from one assembly to another and to reduce the possibility of shortages of the smaller items on rebuild. Tabwashers, split pins and pieces of locking wire must be discarded as they are removed.

REMOVING THE INSTALLATION FITTINGS. Installation connections are fitted to the pump servo connection, to the pump suction connection and to the blower pressure connection; they comprise banjo pillars and banjo adapters with suitable sealing washers. Remove the fittings including the banjo pillars and their joint washers, which consist of rubber rings surrounded by steel washers. Cut and remove all locking wire.

REMOVING THE STRAINER ASSEMBLY. Use the special tool T.161439 to remove the strainer assembly which comprises the strainer element, spring and plug. They are assembled permanently; no attempt should be made to separate the details.

REMOVING THE ADJUSTING SLEEVE ASSEMBLY. Extract the three cheese headed setscrews which retain the adapter plate and remove the adapter plate and diaphragm. Check the piston projection as described on page 11, as the setting may have been disturbed. Remove the operating piston sleeve and operating piston, withdraw the adjusting sleeve from the valve chamber and invert the unit to shake the operating needle out of the sleeve bore.

REMOVING THE VALVE SPRING. Remove the domed nut from the valve spring adjusting screw, slacken the locknut and rotate the screw anticlockwise with spanner T.174678 until it feels free of the spring loading. Slacken the top cover retaining nuts evenly to reduce any remaining load on

the spring. When free, remove the nuts and cover and withdraw the spring and spring plates.

SEPARATING THE CHAMBERS. Insert a screwdriver blade into the valve chamber and prise back the tabs securing the locknut on the small adjusting screw in the rocker lever, remove the locknut with a box-spanner and rotate the screw clockwise as far as possible with a screwdriver until the end of the screw is flush with the surface of the lever. This will allow the screw to clear the adjacent casting when the rocker lever is being withdrawn.

Remove the retaining nuts from the longitudinal studs securing the capsule chamber to the valve chamber, invert the unit so that the half-ball will rest in the rocker lever recess and separate the chambers. It may be necessary to loosen the joint by tapping gently with a hide hammer.

The rocker lever assembly may adhere to the

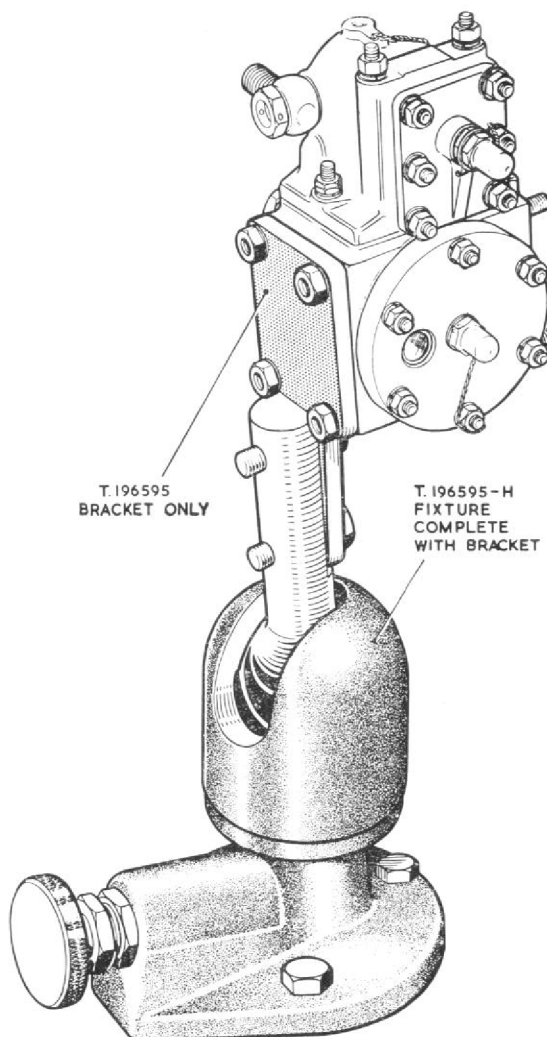


Fig. 4. Dismantling and assembling fixture (T.196595/H complete with bracket).

face of either chamber, in which event it may be eased away as a complete assembly.

Remove and discard the two gaskets on either side of the lever plate.

REMOVING THE ORIFICE. Bend back the tabs of the tab-washer which secures the orifice and unscrew the orifice with box spanner T.164159 inserted through the top of the valve chamber. Remove any shims that may have been fitted under the orifice flange and check their thicknesses to assist in replacement of the orifice on rebuild. Store the orifice and shims in a safe place where no accidental damage will be possible.

REMOVING THE BLOWER PRESSURE DIAPHRAGM. Remove the retaining nuts from the diaphragm cover at the base of the capsule chamber and remove the cover with extractor T.196217 (Fig. 5). Hold the square on the end of the stem with locking plate T.194435 as shown in Fig. 14, and release the diaphragm retaining nut after bending back the locking tabs. Remove the nut and tab-washer then draw off the diaphragm retaining plate, sealing ring, diaphragm, top plate and shims (if fitted).

REMOVING THE CAPSULE ASSEMBLY. The capsule can be removed only when the capsule chamber has been separated from the valve chamber and after the blower pressure diaphragm has been removed.

Slacken the dome nut in the centre of the top cover to facilitate removal of the nut later, remove the top cover retaining nuts and lift the cover complete with the capsule assembly. Remove the dome nut completely and withdraw the capsule upper stem from the cover. Examine the stem flange and the counterbore in the cover for any shims which may have been fitted and store these in a safe place after checking their thicknesses to facilitate reassembly.

DISMANTLING THE ROCKER LEVER ASSEMBLY. It is not advisable to dismantle the rocker lever assembly unless it is damaged, or if leakage is suspected. If dismantling is necessary, however, release the tabwashers, remove the two nuts and withdraw the lever and bush assembly from the lever plate.

Remove and discard the rubber sealing ring, which may remain in the internal recess in the lever plate, or on the lever, when withdrawing the lever and bush assembly.

If the rubber sealing ring remains in the recess in the lever plate, take great care when removing it not to score or damage the surfaces of the recess in any way, as this will lead to severe leakage.

The lever and bush is supplied as a complete

EXTRACTOR
T196217

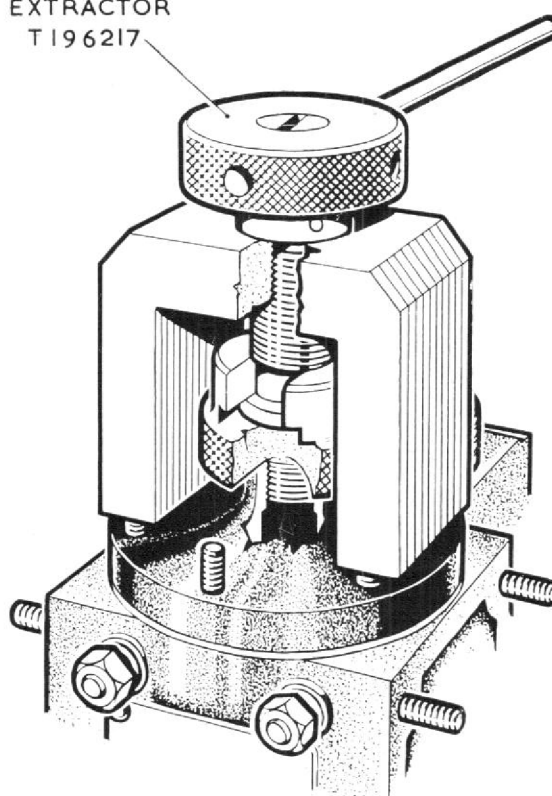


Fig. 5. Removing the blower pressure diaphragm cover using the extractor T.196217.

assembly for replacement and must not be dismantled.

CLEANING

Prior to cleaning remove all remaining joint washers. If any defect in the unit is suspected to be due to the presence of foreign matter the parts suspected should be inspected before cleaning, otherwise the cause of the defect may be washed away.

The components should be cleaned thoroughly by washing in kerosene and dried off by the use of a compressed air blast. It is recommended that a kerosene bath and spray gun be used for cleaning, supplied by a pump with adequate filtering facilities. The compressed air for drying must be free from water. Hard brushes, cloths and abrasives must not be used for cleaning under any circumstances.

After cleaning and drying the components should be placed in clean dry receptacles pending inspection.

INSPECTION

All visual inspection of the components is

described in this section. In instances where dimensional checks of certain components are necessary, the appropriate information will be found in the schedule of fits, clearances and repair tolerances, at the end of this chapter.

Each detail should be examined closely for signs of damage or excessive wear and if considered necessary, with due regard to the nature of the defect and to the function of the component, the part should be discarded and a replacement demanded.

To assist in maintaining the high standard of scrupulous cleanliness required, it is recommended that the surface of the inspection and assembly bench be covered with zinc sheeting, bakelized fabric or linoleum. Following inspection the components should be placed in clean receptacles containing a quantity of light oil for safe storage pending re-build.

DISTORTION CHECKS. Distortion checks normally should not be necessary. Suspected distortion of joint faces may be checked with a surface plate and marking blue in accordance with general practice.

PERMISSIBLE WEAR. All parts which are subject to wear must be checked dimensionally in accordance with the schedule of fits, clearances and repair tolerances at the end of this chapter.

REDUNDANT PARTS. It is usual during inspection to reject all parts rendered redundant by essential modifications; the inspector, therefore, must have complete information covering modifications so that these can be embodied on re-assembly.

SCORES AND SURFACE DAMAGE. Scores and surface damage on moving parts and joint faces generally will impair the operational efficiency of the unit, hence any part so affected should be rejected and a replacement demanded. In certain circumstances however, particularly where the region of operation is an outlying one and spares are not obtainable readily, slight defects which are insufficient seriously to impair the efficiency and safety of the unit may be acceptable at the discretion of the inspector in charge.

INSTALLATION CONNECTIONS. Inspect carefully all adapters and unions for cleanliness and general condition and ensure that all threads are undamaged. The joint faces of banjo connections and pillars must be free from damage or scoring which may prove sources of leakage.

STRAINER ASSEMBLY. Examine the strainer wire for cleanliness and damage and check that there is no distortion of the coils. See that the threads of the plug are free from damage.

ADJUSTING SLEEVE ASSEMBLY. Examine the components generally for any visible defects. The

operating needle, adjusting sleeve bore, operating piston and piston sleeve particularly must be free from scoring, corrosion and other damage; these are the most critical parts of the unit and the smallest defect may result in excessive hysteresis.

Inspect dimensionally the operating piston and the sleeve, also the operating needle and the adjusting sleeve in accordance with the schedule of fits, clearances and repair tolerances at the end of this chapter.

Dry the adjusting sleeve bore and operating needle thoroughly and check that the needle will slide freely in the sleeve. Check the operating piston and sleeve in a similar manner.

Examine the diaphragm for swelling, excessive stretch or distortion and other damage, renewing it if necessary.

Inspect the adapter plate, retaining screws and washers generally for serviceability, ensuring that the threads are clean and undamaged.

CAPSULE ASSEMBLY. Examine the capsule for distortion and damage and for any signs of corrosion particularly between the plates. Check that the threads at each end of the stem are clean and undamaged and that the pin through the lower stem is not worn unduly. See that the square portion and flats at the upper and lower ends of the stem are undamaged.

ROCKER LEVER ASSEMBLY. Visually inspect the rocker lever assembly for damage and distortion. There should be no undue wear on the capsule end of the lever and, at the other end, the half-ball recess should be clean and smooth. The seating faces of the bush must be absolutely free from scores and other surface damage which may cause leakage.

See that the rocker lever adjusting screw and locknut are serviceable, that their threads are clean and undamaged and check that the head of the screw is free from corrosion and indentation due to contact with the end of the operating needle.

HALF-BALL VALVE. Examine the half-ball for serviceability, ensuring that it is free from corrosion and scoring. Check the sealing surface for flatness with an optical flat; if more than two colour-bands are apparent the half-ball should be rejected and a new half-ball fitted.

BLOWER PRESSURE DIAPHRAGM ASSEMBLY. Examine the diaphragm for swelling, distortion, excessive stretching and other damage. Slight indentation of the surface by the sealing rings will be apparent and is acceptable provided that in each case it is little more than a surface mark. If the

indentation is severe however, the diaphragm must be scrapped.

Inspect the diaphragm retaining plate and top plate for damage and see that the surfaces which contact the diaphragm are smooth. Check that the retaining nut is satisfactory and that the threads are clean and undamaged.

ORIFICE. Inspect the lands of the orifice to see that they are clean, smooth and free from damage and corrosion. Check the orifice face for flatness using an optical flat; if no colour registration is obtained on the orifice face and on each of the lands the orifice must be rejected and a new one fitted. Ensure that the bore is clean and unrestricted.

SPRING PLATES AND SPRING. See that the spring plates are thoroughly clean and undamaged, particularly in the bottom of their seating recesses and on the spring seatings. Examine the spring for damage, distortion and surface cracks and check that it is thoroughly clean on the end faces and between the coils.

VALVE CHAMBER. Examine the valve chamber for cleanliness particularly in the filter housing bore and in the orifice retaining bore. Ensure that the joint faces of the top cover and of the connections are free from scoring and other damage which may permit leakage to occur. Check the tapped holes for cleanliness and see that the threads are in good condition.

VALVE CHAMBER TOP COVER. Check the threads in the tapped central hole for cleanliness and general condition. Ensure that the retaining stud holes are clean and that the joint face is free from scoring and other damage which may be a source of leakage. See that the lockwire hole in the cast rib is clear and undamaged. Check that the threads, adjusting square and conical end of the adjusting screw are in good condition.

CAPSULE CHAMBER. Inspect the joint faces for freedom from scoring and other damage likely to result in leakage. See that the external cast surfaces are free from damage and check internally and externally for any signs of oxidization. Examine all studs for general condition and damaged threads.

CAPSULE CHAMBER TOP COVER. Check that the joint face is clean and undamaged and that there is no oxidization present. Make sure that the shims have been removed from the counterbore in the underside of the cover and that the face and edges of the counterbore and capsule anti-rotation slot are clean and undamaged. Inspect the gauze air strainer for damage and for restriction due to accumulation of dirt.

CAPSULE CHAMBER DIAPHRAGM COVER. Inspect the cover generally for damage and oxidization and

see that the threads in the central boss are clean and in good condition. See that the rubber sealing ring has been removed and that the groove is clean.

REBUILDING THE UNIT

Ensure that all details, the assembly bench and all tools are thoroughly clean before commencing to rebuild the unit.

Where gaskets or paper joint washers are used it is advisable to smear the joint face lightly with white petroleum jelly to retain the washer in position whilst offering-up the adjacent components.

Certain pressure tests are necessary during rebuilding and are described in their proper sequence.

ROCKER LEVER ASSEMBLY. If the rocker lever assembly was dismantled, fit a new rubber sealing ring to the internal groove in the lever plate after making sure that the recess is absolutely clean.

Secure the lever and bush assembly to the lever plate with two tabwashers and nuts; tighten the nuts fully but do not lock the tabwashers at this stage.

Lower the assembly into the valve chamber, interposing a gasket between the rocker lever plate and the face of the valve chamber. Secure in position by fitting the special plate T.151165 and suitable nuts and bolts, as shown in Fig. 6.

The securing nuts must be as tight as possible; care being taken to tighten them evenly to avoid distortion of the gasket and rocker lever plate.

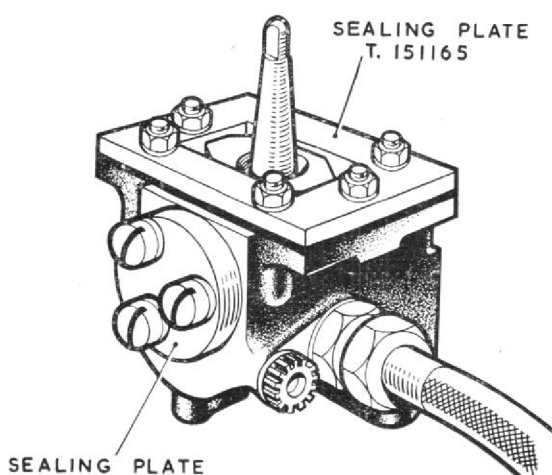


Fig. 6. Pressure testing the pivot plate using the sealing plate T.151165.

PRESSURE TESTING THE ROCKER LEVER ASSEMBLY. Fit the top cover, interposing a joint washer, and seal off with blanking plugs all apertures except for the 'return-to-pump-suction' connection, to which a union suitable for an air line connection should be fitted.

Connect an air line and apply an air pressure of 40 lb. per sq. in. Immerse the assembly completely in kerosene for a period of 5 minutes. There must be no leakage between the lever and bush.

When satisfactory remove the sealing plate, top cover and blanking plugs, remove the rocker lever assembly from the valve chamber and lock the two securing nuts. Fit the operating needle adjusting screw to the rocker lever, screwing it in until the slotted end is flush with the top surface of the lever. Place the locknut where it cannot become mixed with any retaining nuts.

FITTING THE ORIFICE. The orifice is assembled to the valve chamber and the height adjusted by shimming so that when the rocker lever is in the free position, namely, with no load applied to either end, the half-ball is loaded lightly on to the orifice face; this condition is termed 'the rocker lever pre-load'.

Fit the rocker lever assembly to the valve chamber, fit the capsule chamber and retaining nuts and tighten fully. Place the holder T.196218 complete with a dial test indicator on to the top face of the valve chamber as shown in Fig. 7. Adjust the indicator dial to zero with the measuring button resting on the point of the rocker lever spring seating. Lock the dial at the zero setting, remove the complete instrument, separate the chambers and withdraw the rocker lever assembly.

Assemble two 0.012 in. shims over the orifice threads, followed by a new tab washer with the tabs bent up slightly, and screw the assembly into the tapped hole in the bottom of the valve chamber. Tighten the orifice fully with the single tab of the tabwasher protruding over the edge of the adjusting sleeve housing bore. Prise the end of the tab down into the bore, gaining access through the rocker lever aperture.

Re-fit the rocker lever assembly complete with the half-ball. It will be necessary to invert the valve chamber and rocker lever to retain the half-ball in the lever recess whilst they are being assembled. Fit the capsule chamber and retaining nuts and washers. Tighten fully.

Place the dial test indicator on to the valve chamber face again and note the reading with the measuring button contacting the rocker lever point. The reading now should be 0.003 to 0.006 in. on the 'plus' side of the dial, i.e. the half-ball is

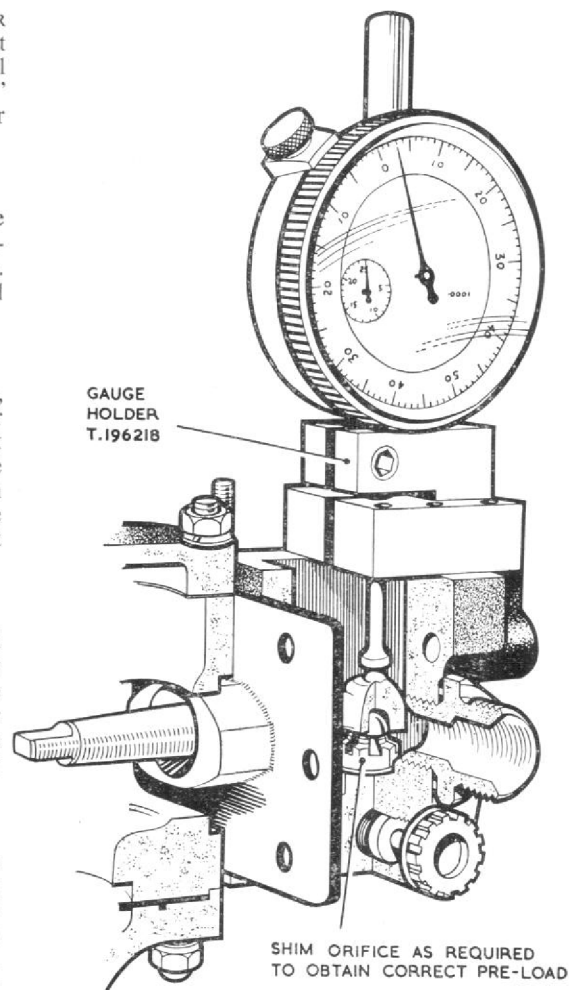


Fig. 7. Adjusting the rocker lever pre-load.

loaded lightly on to the orifice face and is thus lifting that end of the rocker lever by the amount indicated. If the amount indicated is less than that specified, depress the end of the lever to obtain the 'minus' reading, dismantle the assembly and increase the thickness of the shims beneath the orifice by an amount equal to the difference between the indicated 'minus' figure and the specified figure. Should the indicated amount be greater than that specified the shims must be reduced accordingly. Re-build the assembly as before and check again. This process must be repeated until the required figure is obtained, noting that the orifice must be fitted with its tabwasher and must be tightened fully each time. A setting of 0.005 in. is recommended to provide the most desirable pre-load. The combined thickness of the shims and the tabwasher should not exceed 0.060 in.

Should the adjustment required appear excessive it may be found advantageous to reverse or invert the pivot plate on the rocker lever, otherwise a new plate should be tried. If this fails to give a satisfactory result the rocker lever has probably

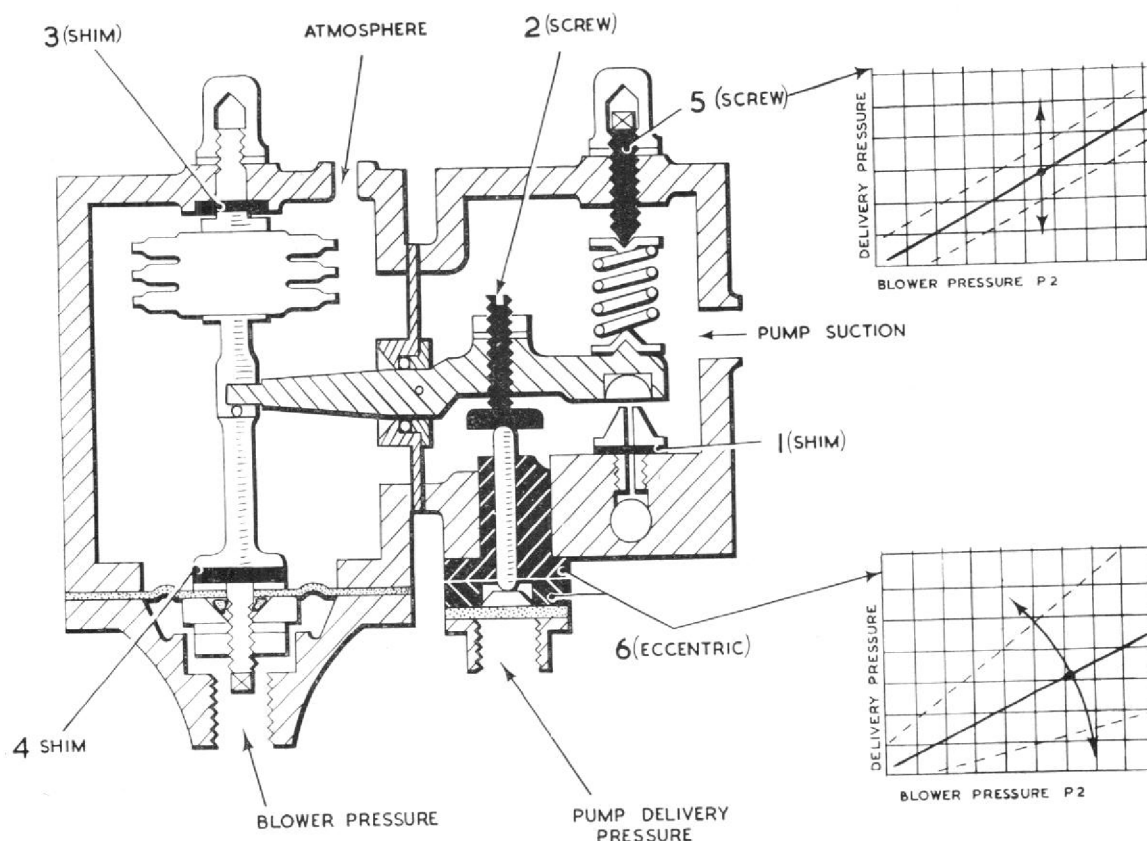


Fig. 8. Schematic diagram of adjustments.

Adjustments during assembly

- (a) Shim orifice (1) to obtain rocker lever pre-load of 0.003 to 0.006 in. See page 9.
- (b) Adjust (2) to give piston height of 0.004 to 0.006 in. above face of cylinder. See page 11.
- (c) Assemble (3) initially with two 0.012 in. shims. See page 12.
- (d) Shim (4) initially to set diaphragm level with face of capsule chamber. See page 12.

Adjustments during calibration

- (e) Adjust (5) to set initial datum point. See

page 13.

- (f) Adjust (3) to obtain fall-away point at blower depression. See page 13.
- (g) Adjust (5) to raise or lower curve bodily. See page 13.
- (h) Adjust (6) to alter slope of curve. Re-check 'f' and 'g'. See page 13 and 14.
- (i) Adjust diaphragm shims (4) only if necessary to balance (5) and (6). Re-check 'f', 'g' and 'h'. See page 14.

been bent or distorted and a new lever assembly should be fitted. When the specified pre-load has been obtained satisfactorily, lock the tabwasher tabs against the orifice hexagon flats.

PRESSURE TESTING THE HALF-BALL VALVE. Place the spring seating plate in position on the rocker lever, insert the valve spring and top plate, fit the adjusting screw to the top cover and fit the cover, ensuring that the conical end of the adjusting screw is seating in the top spring plate recess. Secure the top cover with its retaining nuts and washers and tighten fully. Rotate the adjusting

screw to load the rocker lever, through the valve spring, so that the half-ball is seated firmly on the orifice face.

Insert the strainer assembly complete with an aluminium joint washer, screw in tightly with the special tool T.161439, and insert a suitable union in the fuel pump servo connection. Connect a high-pressure pipe from a convenient fuel supply and apply a fuel inlet pressure of 1650 lb. per sq. in.; there must be no leakage past the half-ball valve.

In the event of leakage occurring remove the half-ball and orifice and check their faces with an optical flat as described on page 7 and 8; renew whichever is defective.

ASSEMBLING THE ADJUSTING SLEEVE. Demagnetize the adjusting sleeve and see that it is thoroughly clean. Fit a joint washer over the sleeve body after smearing a little petroleum jelly on the valve chamber facing, press the washer on to the flange face and align the holes. Insert the sleeve in the valve chamber and push in gently. Rotate the sleeve so that the engraved 'X' on the flange circumference is positioned at the mid-way point, which is at right-angles to the centre-line of the unit.

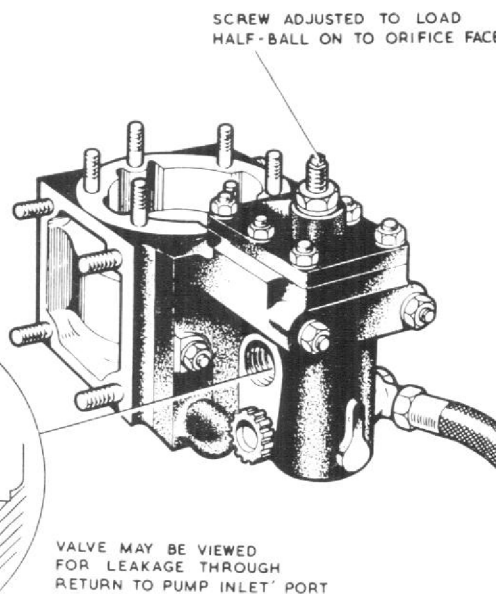
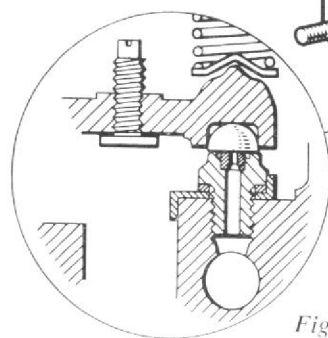


Fig. 10. Pressure testing the half-ball valve.

Slacken the valve spring adjusting screw, remove the valve chamber top cover and lift out the spring and spring plates. Rotate the adjusting screw in the rocker lever anti-clockwise until the head of the screw contacts the underside of the lever. Slacken the screw a half-turn and fit the tabwasher and locknut.

De-magnetize the operating needle and insert it in the adjusting sleeve bore.

Smear the face of the sleeve with white petroleum jelly and fit a joint washer then fit the operating piston sleeve; this has an 'X' engraved on its circumference and should be fitted so that the marking coincides with that on the adjusting

sleeve. Fit the retaining set-screws with additional washers in place of the diaphragm and adapter plate and tighten the assembly.

ADJUSTING THE OPERATING NEEDLE. Invert the unit and insert the piston, small end first, into the operating cylinder. Set the dial micrometer in gauge G.56967 to 0.005 in. using the setting plate provided, place the gauge on the face of the operating sleeve as is shown in Fig. 11, and adjust the piston height by rotating the adjusting screw in the rocker lever with a screwdriver inserted through the top of the valve chamber. The screw is to be adjusted until the dial indicates a projection of 0.004 to 0.006 in. with the half-ball seated firmly on the orifice face by finger pressure on top of the rocker lever. When the setting is satisfactory, tighten the adjusting screw locknut and check the setting again, correcting it if necessary, before locking the tabwasher.

Remove the micrometer, remove the operating sleeve retaining setscrews and fit the operating diaphragm. It may be found that one face of the diaphragm is smooth whilst the other face is coarsely grained; the coarse face should be fitted towards the operating piston.

Fit the adapter plate, washers and setscrews and tighten fully.

Refit the valve spring and plates, fit the top cover, washers and retaining nuts and tighten fully. Screw in the adjusting screw to restore the valve spring loading, fit the locknut and tighten finger tight. Do not fit the dome nut as the loading will require adjustment on test.

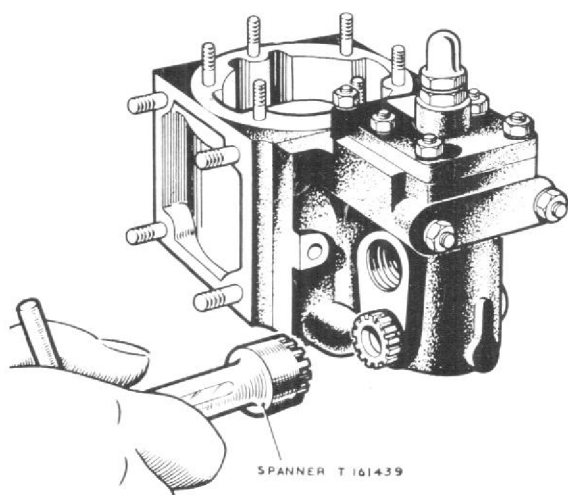


Fig. 9. Fitting the strainer assembly using the spanner T.161439.

PRESSURE TESTING THE VALVE CHAMBER ASSEMBLY. With the valve chamber assembled

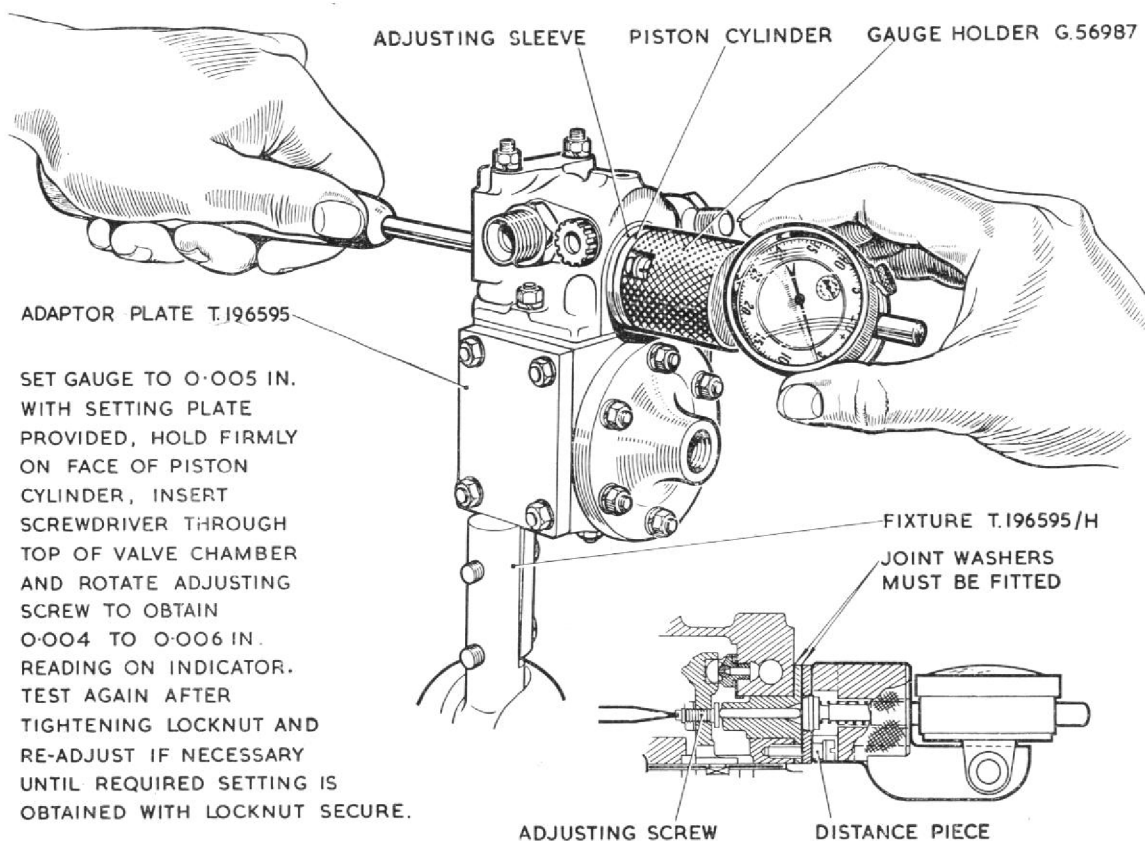


Fig. 11. Adjusting the operating needle.

pump-suction' connection and connect an air supply. Immerse the unit completely in kerosene and apply an air pressure of not more than 40 lb. per sq. in. for a period of 1 minute.

FITTING THE CAPSULE ASSEMBLY. Separate the capsule chamber from the valve chamber taking care to avoid disturbing the rocker lever assembly.

Assemble two 0.012 in. shims to the capsule upper stem or refit the shims removed during dismantling.

Insert the upper stem of the capsule stack into the capsule chamber cover and ensure that the flats on the stem shoulder engage with the flats in the rim of the counterbore in the cover. Fit the washer and retaining dome nut and tighten finger tight. Place the assembly in the capsule chamber and fit two retaining nuts to hold the cover. The cover joint washer must be fitted.

Refit the capsule chamber to the valve chamber, ensuring that the aperture in the capsule lower stem passes over the end of the rocker lever. Fit the retaining nuts and washers and tighten fully.

Place two shims over the lower end of the capsule stem so that the shims bear against the

flange, then fit the diaphragm top plate, diaphragm, retaining plate, washer and nut in that order. Tighten the nut finger tight.

The diaphragm should lie flat and the centre should be level with the periphery when this is in contact with the capsule chamber face. If the diaphragm does not lie level remove the details and adjust by adding or removing shims as required.

When satisfactory remove the retaining nut, washer and retaining plate, pass a sealing ring over the end of the stem so that the ring is in contact with the diaphragm, refit the retaining plate and nut, with a plain washer, and tighten fully.

Place a rubber sealing ring in the groove in the face of the diaphragm cover, fit the cover, plain washers, spring washers and retaining nuts, and tighten fully.

PRESSURE TESTING THE DIAPHRAGM. Remove the capsule retaining dome nut, top cover retaining nuts and top cover. Fit a suitable adapter to the diaphragm cover and connect an air line. Apply an air pressure of 80 lb. per sq. in. and maintain this pressure for 5 minutes with the unit immersed completely in kerosene. There must be no leakage through or across the diaphragm.

Refit the capsule chamber top cover and capsule retaining dome nut and fit the appropriate unions and adapters for installation on the test rig.

CALIBRATING AND RIG TESTING

The fuel to be used throughout the test is Aviation Kerosene to Specification D. ENG. R. D. 2482. The temperature of the fluid entering the Air Fuel Ratio Control unit must be between 20 deg. C. and 50 deg. C. A fuel inlet pressure at the rig pump inlet is to be maintained at 10 lb. per sq. in.

For the calibration and performance test the unit is mounted on the test rig as shown in Fig. 14. The calibration values and performance requirements vary according to the requirements of different engine installations, but as the test procedure is similar for all types, a standard basic test schedule is described which is applicable to all units.

During the final test the performance figures are to be recorded on a test certificate and must be approved by an inspector.

SETTING THE CAPSULE EFFECTIVE RANGE. Install the unit on the rig. Check that the flowmeter cock is open and that the restricting cock is set to minimum pressure.

Start the rig pump and allow the rig to run for a few minutes to stabilize and attain its working temperature.

Close the restrictor cock until the flow is as stated for zero blower pressure on the calibration table and set the delivery pressure to within the corresponding specified limits by means of the valve spring adjusting screw; rotate the screw clockwise to increase and anti-clockwise to decrease the pressure.

Open the vacuum pump cock gradually and check that the delivery pressure ceases to fall, and remains constant with continued increase in depres-

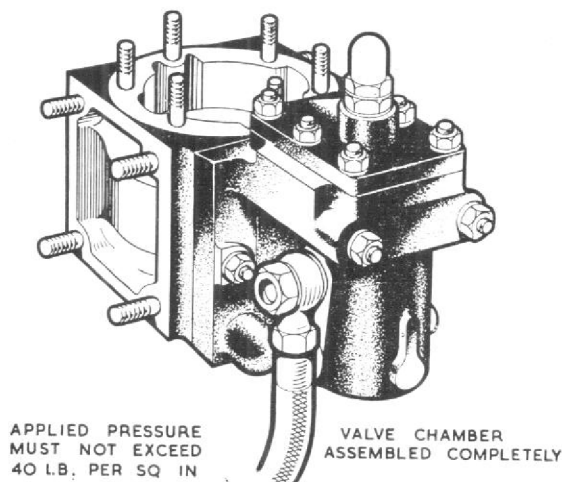


Fig. 12. Pressure testing the valve chamber assembly.

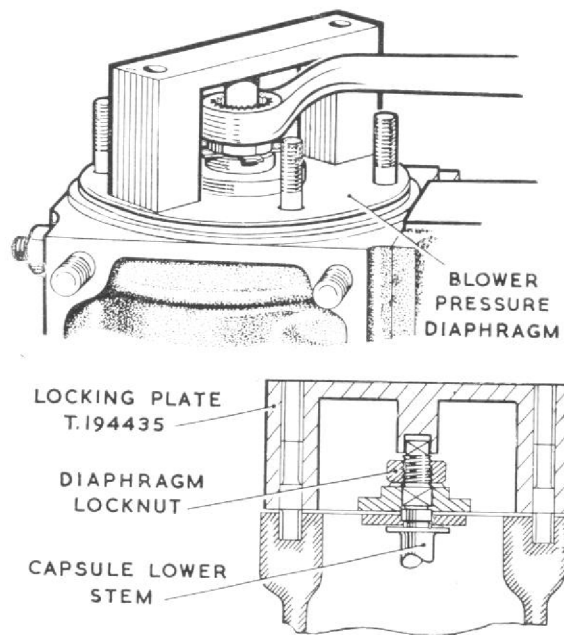


Fig. 13. Tightening the diaphragm locknut.

sion, between 8 in. Hg. and 5 in. Hg. blower pressure (Absolute).

Should the depression be outside either limit close the vacuum cock and stop the rig pump. Remove the capsule dome nut and top cover and if the depression required to obtain the constant delivery pressure was greater than the maximum limit stated in the table, the thickness of the shims must be increased, whilst the thickness must be decreased if the depression was less than the minimum.

Start the rig pump and check again, adjusting the shims as required until a satisfactory result is obtained.

PERFORMANCE CALIBRATION TABLE

Blower Pressure (lb. per sq. in.)	Flow G.P.H.	Delivery pressure (lb. per sq. in.)	
		Minimum	Maximum
70	450	1565	1625
60	420	1415	1475
50	400	1260	1310
40	360	1110	1155
30	300	960	1000
20	230	810	840
10	160	660	685
0	80	500	520
10 in. Hg. (Abs.)	30	350	370

PRELIMINARY CALIBRATION. Start the rig and when it has stabilized set the blower pressure and flow to a value mid-way up the test schedule calibration table and adjust the restrictor cock to produce the corresponding flow, when the delivery pressure should be between the appropriate limits stated in the table. Adjust if necessary as described in the previous column.

Increase the blower pressure and flow to the

maximum value stated and note the indicated delivery pressure, recording this as point 'b'.

Reduce the blower pressure and flow to the minimum positive value stated and again note the indicated delivery pressure, recording it as point 'a'.

If at point 'a' and 'b' the indicated delivery pressure is in both cases above the maximum or in both cases below the minimum stated in the table, rotate the valve spring adjusting screw IN to RAISE the pressure or OUT to LOWER it, setting this adjustment so that the indicated delivery pressure is just within the minimum limit at point 'a'.

Increase blower pressure and flow to point 'b' and check again. If the delivery pressure is within the stated limits, return to the lowest value in the table, which in some cases may be a depression given as Absolute pressure. Carry out a complete check at each value specified in the table and check at each value again for hysteresis on the return to minimum pressure. The unit may be considered satisfactory if at all values the delivery pressure is within the stated limits and hysteresis does not exceed the permissible figure.

ADJUSTING THE AMPLIFICATION RATIO. Reverting to the initial check on page 13, if it is found that at point 'a' the indicated delivery pressure is outside either limit whilst at point 'b' it is outside the opposite limit, that is, outside the minimum limit at point 'a' and outside the maximum limit at point 'b', or vice versa, the slope of the performance curve is incorrect. This is rectified by rotating the operating needle adjusting sleeve to alter the amplification ratio. The amplification ratio is adjustable between 15.2 : 1 and 15.8 : 1.

After removing the three retaining setscrews from the adjusting sleeve assembly, locate the 'X' marking on the sleeve flange and cylinder and rotate the assembly one or more holes to move the 'X' towards the capsule chamber to increase the angle of the slope, that is, to raise the pressure at point 'b' towards the maximum limit. Conversely, the sleeve is rotated to move the 'X' marking away from the capsule chamber to lower the indicated pressure at point 'b', and decrease the slope angle. See Fig. 8.

NOTE: Each hole in the adjusting sleeve flange alters the delivery pressure by approximately 40 lb. per sq. in.

The blower pressure and flow must now be reduced again to the specified minimum pressure, which may have altered slightly with the alteration in amplification ratio. If the alteration has been sufficient to throw the indicated delivery pressure outside either limit the valve spring adjusting screw must be reset to restore the figure to within the required limits, after which the unit must be tested again over the full range. Before readjusting the spring loading however, the capsule effective range (fall-away point) must be re-checked as described on page 13, and the shims altered as necessary.

If it is found that the calibration cannot be obtained satisfactorily by adjustment of the amplification ratio and valve spring loading as described, a fine adjustment is provided by the shims under the blower pressure diaphragm. These shims compensate for the elasticity of the diaphragm and increasing the thickness of the shimming will have the effect of increasing the delivery pressure slightly at a given blower pressure and flow value, whilst conversely a reduction in shim thickness will have the effect of decreasing the delivery pressure.

After making any alteration to the diaphragm shimming the unit must be re-tested over the entire range and the fall-away point, amplification ratio and valve spring loading re-adjusted as necessary.

It is essential that the capsule effective range (fall-away point) be re-checked as described on page 13 whenever the diaphragm shims, amplification ratio or valve spring loading are altered.

PRELIMINARY TEST. Run the rig in stages at increasing blower pressures and fuel flows in accordance with the values specified in the calibration table. At each stage record the pump delivery pressure, which must be within the stated limits over the full range of the test.

When the maximum blower pressure and flow has been reached begin to reduce these values and during the return down the range, pause at each given stage and record the delivery pressure alongside those recorded previously. Any difference between the two readings at any one stage indicates the amount of operating needle hysteresis and must not exceed the hysteresis limit of 10 lb. per sq. in.

In the event of excessive hysteresis, stop the rig, remove the operating needle and adjusting sleeve assembly and examine the needle closely for a slight score or a minute particle of foreign matter or corrosion.

Clean the needle and sleeve bore thoroughly and pass the needle through a de-magnetizing coil before refitting it to the adjusting sleeve.

If the hysteresis is still excessive fit a new needle or sleeve, whichever is found to be defective. Whenever a new needle or sleeve is fitted the needle adjustment must be checked and re-set if necessary as described on page 11, and the calibration must be checked and adjusted if required as described on page 13.

INITIAL ENDURANCE TEST. Following satisfactory results from the preliminary calibration and test, the unit must be subjected to a cyclic endurance test during which the blower pressure is to be varied over a given range at regular intervals. The range of blower pressure is to be varied from 0 to 80 lb. per sq. in. (gauge) every 2 minutes for 30 minutes.

STRIP INSPECTION. After completing the initial endurance test the unit is transferred to the assembly bench to be dismantled, when all working parts are to be inspected for wear and possible defects.

Remove the operating needle and adjusting sleeve assembly and inspect the parts thoroughly for signs of undue wear or scoring. If blisters are apparent on the operating diaphragm a new diaphragm must be fitted on re-build.

Remove the blower pressure diaphragm cover and examine the diaphragm surface for severity of sealing ring indentation, excessive stretch and any signs of deterioration.

Slacken the valve spring adjusting screw, remove the valve chamber top cover and remove the spring assembly. Separate the capsule chamber from the valve chamber, remove the rocker lever and the half-ball and examine the faces of the half-ball and orifice for undue wear. Check for wear on the capsule end of the rocker lever.

Should any component prove to be unsatisfactory it must be discarded and a replacement fitted.

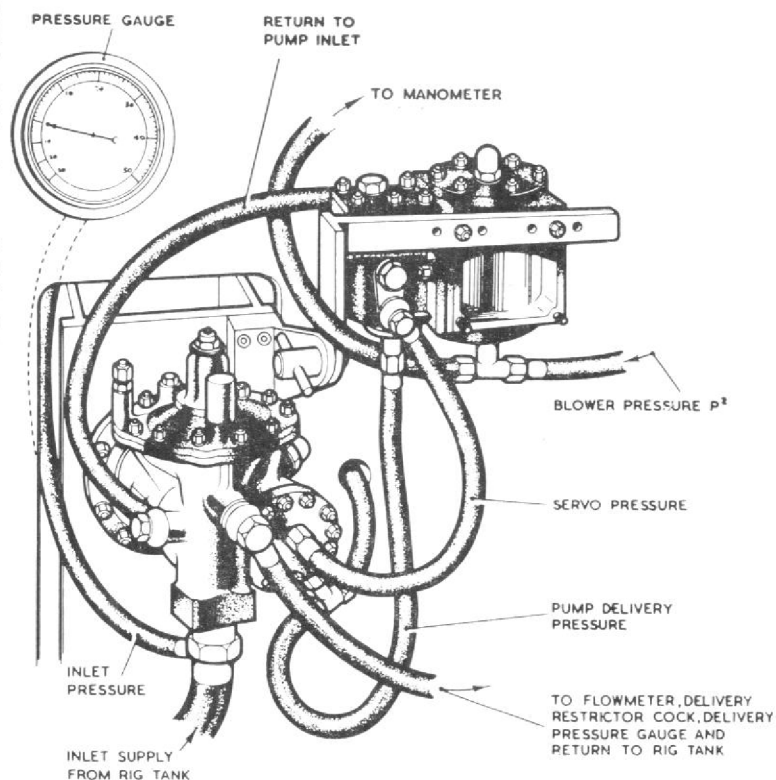


Fig. 14. Installation on the test rig.

Following the general inspection of the components, the unit is to be rebuilt. If either the orifice, rocker lever assembly or blower pressure diaphragm assembly have been dismantled they must be rebuilt and pressure tested in accordance with the appropriate instructions given on pages 9, 10, 11, and 12 of this chapter. Inhibit the capsule by pouring oil to Specification DTD.587 into the capsule chamber to cover the capsule, then allow the surplus to drain before re-assembling to the valve chamber.

FINAL ENDURANCE TEST. The unit must be re-calibrated and tested as described on page 13, after which it must be subjected to a final endurance test.

In the final endurance rig test the blower pressure is to be varied over a given range at regular intervals. The range of blower pressure is to be varied from 0 to 80 lb. per sq. in. (gauge) every 2 minutes for $1\frac{1}{2}$ hours.

FINAL CALIBRATION. Following the final endurance test the unit must be re-calibrated and performance tested as described on page 13. The performance and hysteresis figures obtained must be in accordance with the calibration table on page 13.

When the calibration is satisfactory remove the blower pressure diaphragm cover, remove the nut and plain washer from the capsule stem, fit a new tab-washer, refit the nut, tighten fully and lock the

tab-washer. Refit the diaphragm cover and pressure test as described on page 12.

NOTE: The calibration must be re-checked to ensure that the disturbance of the capsule chamber top cover for pressure testing has not affected the fall-away point.

The final calibration figures must be recorded on the test certificate and approved by an inspector.

PREPARING FOR DISPATCH

INHIBITING. Connect a suitable oil supply to the pump servo inlet connection and flush the valve chamber with oil, to Specification DTD.587, allowing surplus oil to drain from the pump suction union. The capsule chamber is inhibited for convenience during final re-build as described in the previous column.

ASSEMBLING THE INSTALLATION FITTINGS. Refit the appropriate installation fittings to the unit in accordance with the particular engine type for which the unit is required. Where rubber sealing washers surrounded by steel washers are used ensure that the rubber is not trapped on the edge of the steel washer before tightening the connection.

WIRE LOCKING. Wire lock the components where required with stainless steel 22 SWG locking wire.

FINAL INSPECTION. Fit dust caps to all con-

nections, check that the wire locking is satisfactory, that the name plate is secure, and that the information on the plate corresponds with the actual details

of the unit and of the test certificate. See that the test certificate is complete and approved by an inspector.

FITS, CLEARANCES AND REPAIR TOLERANCES FOR AIR-FUEL RATIO CONTROL TYPE AFR. 3

(To be issued later)

Adjacent Parts	Individual Parts	DIMENSIONS		CLEARANCES		REMARKS
		New	Permissible Worn	New	Permissible Worn	
SPRING—VALVE						To be inspected visually for defects

CALIBRATION SCHEDULE 'F'

AIR-FUEL RATIO CONTROL, TYPE A.F.R.

FUEL—the fuel to be used throughout the tests is to be Aviation Kerosene to specification D.ENG.RD.2482 and is to be maintained at a temperature of 20 deg. C to 50 deg. C.

FUEL INLET PRESSURE—the pressure at the rig-pump inlet is to be maintained at 5 to 10 lb. per sq. inch throughout the tests.

LEAKAGE TESTS.

With an air pressure of 40 lb. per sq. inch maintained for 5 minutes, there must be no leakage.

With a fuel inlet pressure of 2000 lb. per sq. inch there must be no leakage past the half-ball valve.

With an air pressure of 80 lb. per sq. inch maintained for 5 minutes, there must be no leakage.

CAPSULE EFFECTIVE RANGE.

The delivery pressure is to become constant (i.e. cease to decrease with continued decrease in blower pressure) between 8 inches Hg.Abs. and 5 inches Hg.Abs. blower pressure.

PRELIMINARY CALIBRATION AND TEST.

Nominal amplification ratio is to be 15.5:1.

Rig pump servo flow to be 11.4 to 11.6 gallons per hour at 1000 lb. per sq. inch and 150 gallons per hour main flow.

Blower Pressure (lb. per sq. inch)	Flow (gall. per hour)	Delivery Pressure (lb. per sq. inch) Gauge	
		Min.	Max.
70	450	1565	1625
60	420	1415	1475
50	400	1260	1310
40	360	1110	1155
30	300	960	1000
20	230	810	840
10	160	660	685
0	80	500	520
10 inches Hg. (Abs.)	30	350	370

Hysteresis should not exceed 10 lb. per sq. inch. After setting the unit, zero blower pressure is to be applied and the servo flow is to be restricted and de-restricted as rapidly as possible for 5 cycles, permitting pump stall pressure to act on the unit, after which the calibration is to be re-set if necessary prior to the endurance test.

INITIAL ENDURANCE TEST.

The blower pressure is to be varied from 0 to 120 lb. per sq. inch (gauge) for 15 cycles or for 30 minutes, whichever is the greater number of cycles.

PARTIAL STRIP AND RE-BUILD.

Partially dismantle, inspect for wear and rebuild.

Repeat leakage test of pivot plate, half-ball valve and blower pressure diaphragm.

FINAL ENDURANCE TEST.

The unit is to be re-calibrated.

The blower pressure is to be varied from 0 to 120 lb. per sq. inch (gauge) for 45 cycles or for 90 minutes, whichever is the greater number of cycles.

On completion of final endurance test, the values of delivery pressure at each blower pressure setting in the table must not vary by more than 40 lb. per sq. inch from the results obtained in the pre-endurance calibration.

FINAL CALIBRATION.

The unit is to be re-calibrated and performance tested in accordance with the table. The performance test results are to be entered on the test certificate.

DISPATCH.

The unit is to be flushed with oil to specification DTD.587.

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